WE CLAIM:

1. A high impedance structure, comprising:

at least two layers, each said layer presenting a high impedance to the E field component of a different respective signal frequency, each said layer also being transparent to the E fields of lower frequency signals, and presenting a conductive surface to the E field of higher frequency signals; and

the bottommost said layer presenting a high impedance to the E field of the lowest frequency of said signals, and each succeeding layer presenting a high impedance to the E field of successively higher frequencies.

2. The structure of claim 1, wherein each said layer presents a series of resonant L-C circuits to the E field of its respective signal frequency.

3. The structure of claim 1, wherein each said layer comprises a substrate of dielectric material having a top and bottom surface and a plurality of radiating elements on said substrate's top surface, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

4. The structure of claim 3, wherein said radiating elements comprise parallel conductive strips.

5. The structure of claim 3, wherein said radiating elements comprise conductive patches.

6. The structure of claim 4, wherein corresponding

conductive strips of said layers are vertically aligned. further comprising conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

7. The structure of claim 4, wherein said conductive strips on each said layer have uniform widths and uniform gaps between adjacent strips.

8. The structure of claim 5, wherein the widths of said strips decreases and the width of said gaps increases with succeeding said layers from the bottommost said layer to the topmost.

9. The structure of claim 5, wherein corresponding conductive patches of said layer are vertically aligned, further comprising conductive vias through said substrates between said aligned conductive patches and said conductive layer.

10. The structure of claim 5, wherein said conductive patches on each said layer are equally spaced and have a uniform gaps between adjacent said patches.

11. The structure of claim 5, wherein the size of said patches decreases and the width of said gaps between adjacent patches increases with succeeding said layers from the bottommost layer to the topmost.

12. The structure of claim 3, wherein the substrate thicknesses from the top to the bottom layer are progressively thicker, wherein radiating elements of said layers are vertically aligned, further comprising

conductive vias through said substrates between said aligned radiating elements and said conductive layer.

13. The structure of claim 12, wherein said radiating elements are substantially the same size at all said layers.

14. A rectangular waveguide for transmitting electromagnetic signals, comprising:

a rectangular waveguide having four walls comprising two opposing sidewalls and a top and bottom wall; and

a high impedance wall structure having at least two layers, at least said sidewalls or said top and bottom walls having said layered wall structure, each layer of said structure presenting a high impedance to the E field of a different signal frequency.

15. The waveguide of claim 14, further comprising an electromagnetic signal source at one end of said waveguide arranged to direct electromagnetic signals into said waveguide with an E field transverse to the waveguide axis and parallel to said wall structure.

16. The waveguide of claim 14, further comprising an amplifier mounted at the opposite end of the waveguide to amplify signals transmitted through the waveguide from said signal source.

17. The waveguide of claim 14, wherein said amplifier is an amplifier array.

18. The waveguide of claim 14, for a signal having a horizontal polarization, said high impedance wall structure

provided on sidewalls of said waveguide.

19. The waveguide of claim 14, for a signal having a vertical polarization, said high impedance wall structure provided on sidewalls of said waveguide.

20. The waveguide of claim 14, for a signal having vertical and horizontal polarizations, said wall structure provided on all four walls of said waveguide.

21. The waveguide of claim 14, wherein each said layer of said structure comprises a substrate of dielectric material having a top and bottom surface and a plurality of radiating elements on said substrate's top surface, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

22. The waveguide of claim 21, wherein said radiating elements comprise parallel conductive strips longitudinally oriented down said waveguide.

23. The waveguide of claim 22, wherein corresponding conductive strips of said layers are vertically aligned. further comprising conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

24. The waveguide of claim 22, wherein said conductive strips on each said layer have uniform widths and uniform gaps between adjacent strips.

25. The waveguide of claim 22, wherein the widths of said strips decreases and the width of said gaps increases with

succeeding said layers from the bottommost said layer to the topmost.

26. The waveguide of claim 14, each said layer forms a series of resonant L-C circuits to electromagnetic wave at a respective frequency with an E field transverse to said conductive strips.

27. A multiple frequency electro-magnetic signal amplifier, comprising:

a waveguide input section having a rectangular cross section and four walls, further having a layered high impedance wall structure on two opposing walls;

a waveguide amplifier section having a rectangular cross section and four walls, further having a amplifier array mounted midway through said amplifier section and a layered high impedance wall structure on said four walls; and

a waveguide output section having a rectangular cross-section and four walls, further having a layered high impedance wall structure on two opposing wall, wherein each said layer of said wall structure in each said section has two or more layers, each said layer presenting as high impedance to respective frequency E field that at least partially transverse to the waveguide axis and parallel to said wall structure, and a low impedance parallel to the waveguide axis.

28. The amplifier of claim 27, wherein said four walls of said input section comprise two sidewalls and a top and bottom wall, said layered high impedance wall structure mounted on said sidewalls.

29. The amplifier of claim 27, wherein said four walls of said output section comprise two sidewalls and a top and bottom wall, said layered high impedance wall structure on said top and bottom walls.

30. The amplifier of claim 27, wherein said amplifier section further comprises two matching polarizers, one matching polarizer mounted on each side of said amplifier array, said layered high impedance wall structure on said sidewalls and said top and bottom walls.

31. The amplifier of claim 27, wherein each said layer of said wall structure comprises a substrate of dielectric material having a top and bottom surface and a plurality of radiating elements on said substrate's top surface, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

32. The amplifier of claim 31, wherein said radiating elements comprise parallel conductive strips longitudinally oriented down said waveguide.

33. The amplifier of claim 32, wherein corresponding conductive strips of said layers are vertically aligned, further comprising conductive vias through said dielectric substrates, between said aligned conductive strips and said conductive layer.

34. The amplifier of claim 32, wherein said conductive strips on each said layer have uniform widths and uniform gaps between adjacent strips.

35. The amplifier of claim 32, wherein the widths of said

strips decreases and the width of said gaps increases with succeeding said layers from the bottommost said layer to the topmost.

36. The amplifier of claim 27, each said layer forms a series of resonant L-C circuits to electromagnetic wave at a respective frequency with an E field transverse to said conductive strips.

37. A microstrip antenna for transmitting multi frequency electro-magnetic signals, comprising:

a microstrip resonator; and

a high impedance surface structure having at least two layers, wherein each said layer presenting as a high impedance to a different frequency E field, said microstrip line resonator etched on said layered high impedance surface.

38. The antenna of claim 37, wherein each said layer of said layer comprises a substrate of dielectric material having a top and bottom surface and a plurality of radiating elements on said substrate's top surface, and further comprising a conductive layer on the bottom surface of the bottommost layer's dielectric substrate.

39. The antenna of claim 38, wherein said radiating elements comprise conductive patches.

40. The antenna of claim 39, wherein corresponding conductive patches of said layers are vertically aligned, further comprising conductive vias through said dielectric substrates, between said aligned conductive strips and said conductive layer.

41. The antenna of claim 39, wherein said conductive patches on each said layer have uniform gaps between adjacent patches.

42. The antenna of claim 39, wherein the size of said patches decreases and the width of said gaps increases with succeeding said layers from the bottommost said layer to the topmost.

43. The antenna of claim 37, each said layer forms a series of resonant L-C circuits to electromagnetic wave at a respective frequency with an E field transverse to said conductive strips.

44. The antenna of claim 40, wherein the substrate thicknesses from the top to the bottom layer are progressively thicker.

45. The antenna of claim 44, wherein said radiating elements are substantially the same size at all said layers.